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Long Term Physical Health Consequences of Adverse Childhood Experiences

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Abstract

This study examined associations between adverse childhood family experiences and adult physical health using data from 52,250 US adults aged 18–64 from the 2009–2012 Behavioral Risk Factor Surveillance System (BRFSS). We found that experiencing childhood physical, verbal, or sexual abuse, witnessing parental domestic violence, experiencing parental divorce, and living with someone who was depressed, abused drugs or alcohol, or who had been incarcerated were associated with one or more of the following health outcomes: self-rated health, functional limitations, diabetes, and heart attack. Adult socioeconomic status and poor mental health and health behaviors significantly mediated several of these associations. The results of this study highlight the importance of family-based adverse childhood experiences on adult health outcomes and suggest that adult SES and stress-related coping behaviors may be crucial links between trauma in the childhood home and adult health.

INTRODUCTION

A substantial literature addresses the associations between childhood household dysfunction and physical and mental well-being in adulthood. For a systematic review of this literature, see Norman et al. 2012. Children who are exposed to emotional, physical, or sexual abuse and other adverse conditions are at greater risk of several negative health outcomes in adulthood, including poor self-rated health, chronic diseases, functional limitations, premature mortality, and poor mental health (Amato 1991; Bauldry et al. 2012; Bonomi et al. 2008; Felitti et al. 1998; Kelly-Irving et al. 2013; Stack 1990). Given that early-life adversities lay a critical foundation for long-term health trajectories, the social and economic consequences of adverse childhood experiences (ACEs[1]) are potentially far-reaching. ACEs can result in significant economic costs in the form of lost employment productivity and tax revenue and increased safety net and health care spending (Tang et al. 2006; Zielinksi 2009).

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[2]The traditional R^2 that is calculated for OLS models cannot be calculated for logistic models. The McFadden's pseudo-R^2 is not interpreted as the percentage of variation in the outcome that can be explained by the model, as in traditional OLS regression. Instead, the McFadden's pseudo-R^2 should be viewed as one possible measure of model fit.

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ACEs are also associated with reduced adaptability and increased social isolation (Elliott et al. 2005), reduced self-esteem (Oates 1984), and increased rates of dissociation and anger hostility (Teicher et al. 2006). Yet we still know little about the complex pathways between ACEs and poor adult health outcomes, and how these pathways may vary across different adverse conditions and health outcomes.

The family is one of the most important contexts for human development. If the origins of adult disease and health disparities emerge in the childhood family environment (Shonkoff et al. 2009), then ameliorating these problems for children should help to protect their health over the life course. Accordingly, the objectives of the present study are to 1) examine whether there are significant associations between nine specific ACEs (physical abuse; sexual abuse; verbal abuse; witnessing parental domestic violence; experiencing parental divorce; living with anyone who was depressed, mentally ill, or suicidal; living with anyone who was a problem drinker or alcoholic; living with anyone who abused drugs; or living with anyone who was incarcerated, and four specific adult health outcomes (self-rated health, the presence of functional limitations, diabetes, and experiencing a heart attack; 2) determine whether adult socioeconomic status (SES) and/or poor mental health and stress-related coping behaviors serve as potential pathways linking ACEs with adult health; and 3) determine whether these mechanisms linking adversities during childhood to adult health vary for different adversities and different health outcomes.

BACKGROUND

Understanding the Link between Adverse Childhood Experiences and Adult Health

Insofar as ACEs contribute to the development of risk factors for poor health, then exposure to them should be recognized as a social determinant of health (Greenfield 2010). Previous research has found that childhood physical, verbal, and sexual abuse, witnessing parental domestic violence, parental divorce during childhood, and living with anyone who was depressed, abused substances, or was imprisoned are associated with increased odds of poor self-rated health and experiencing several chronic diseases and disorders in adulthood (Felitti et al. 1998; Irving and Ferraro 2006; Roettger and Boardman 2012; Schafer and Ferraro 2012; Springer et al. 2007; Springer 2009). While important, these studies have either examined one adverse experience at a time or summed them to create a cumulative ACE index, limiting our ability to understand which particular experiences are associated with each health outcome.

Although some researchers have argued that early risk factors have the potential to have enduring effects on individual life trajectories (Dannefer 2003; Ferraro and Kelley-Moore 2003), there may also be countervailing mechanisms to reduce the effects of early disadvantage on health (Ferraro and Kelley-Moore 2003). Identifying and targeting the

[1]We use the term ‘adverse childhood experiences’ or ‘ACE’ throughout this paper to refer specifically to the nine types of childhood household dysfunction we examine: physical, verbal, and sexual abuse, parental divorce, parental domestic violence, and living with someone who is depressed, abuses drugs, abuses alcohol, or who has been incarcerated. Although a number of negative conditions could be considered adverse childhood experiences (e.g., poverty, poor neighborhood conditions, poor housing infrastructure, bullying), those experiences are not the focus of this paper.

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potential links between ACEs and adult health may help to reduce one potential cause of health disparities throughout the life course.

Mechanisms Linking Adverse Childhood Experiences to Poor Health in Adulthood

The life course perspective is the dominant theoretical framework for understanding how conditions in childhood affect individuals throughout their lives. From this perspective, disadvantage is transmitted from parents to children through multiple pathways, and these early experiences can affect adult health through cumulative social and economic damage over time (Elder 1998; Hayward and Gorman 2004) and through the "biological embedding of adversities during sensitive developmental periods" (Shonhoff et al. 2009, 2252). Childhood is a particularly salient stage of development, and thus, adverse events during childhood have the potential to influence developmental pathways and shape the character and content of later life (Bauldry et al. 2012; Macmillan 2001). ACEs in the family environment may shape exposure to direct and indirect health risks, including disruption of neuroendocrine and immune functioning due to chronic arousal of the body's physiologic response to stress (Shonkoff et al. 2009); depression, PTSD, negative health attitudes and beliefs (Kendall-Tackett 2002); and economic tenuousness, stressful home environments, and poor health behavior choices in adulthood (Repetti et al. 2002), consequently leading to health disparities over the life course.

There are also sociological pathways related to decision-making and the accumulation of human capital that may explain the relationship between ACEs and poor adult health (Caspi 1987; Clausen 1991; Elder 1994; Macmillan 2001). The present research uses a large, diverse sample of US adults to examine two specific pathways that may link nine different ACEs and three specific adult health outcomes. Specifically, ACEs may be associated with negative health outcomes in adulthood through adult SES and/or stress and coping strategies that involve unhealthy lifestyle behaviors. Although these proposed pathways are not exhaustive of all potential mechanisms, they provide two useful starting points for understanding the links between ACEs and adult health.

Socioeconomic Status—We know a great deal about how childhood SES impacts adult health. Children who grow up in low SES households have worse self-rated health, higher chronic disease and mortality rates, and more functional limitations in adulthood compared to those who grew up in higher SES households (Bauldry et al. 2012; Hayward and Gorman 2004). In addition, Laaksonen et al. (2005) found that adult SES is associated with health independently of childhood economic difficulties. Few empirical studies, however, examine adult SES as a potential pathway linking ACEs to adult health, and those that do tend to focus on one type of adverse experience (usually physical or sexual abuse). There is some theoretical and empirical support for the idea that ACEs may be associated with adult SES, *net of the effects* of childhood SES. Children who grow up in unhealthy, unstable, or dangerous environments may be at greater risk of what Merton (1938) referred to as ritualism and retreatism. Retreatism involves rejecting goals and societal norms, and ritualism involves conforming to social norms related to legitimate means of attaining goals but lowering expectations, aspirations, and ambitions toward achieving those goals. Expanding on Merton, Agnew (1999) suggests that exposure to negative stimuli, like

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physical abuse or witnessing parental violence in the home, increases the likelihood of rejection of conventional goals. Both ritualism and retreatism are associated with reduced effort to achieve success, resulting in lower educational attainment, lower likelihood of employment, and less income (Covey et al. 2013).

There is empirical evidence of negative educational and socioeconomic consequences of abuse in childhood. Abused children have been found to have lower IQ scores (Sadeh et al 1994), worse school achievement (Eckenrode et al. 1993), diminished educational aspirations and effort (Macmillan 2000), and lower educational attainment (Widom 1989). These educational deficits are then likely to result in worse employment prospects, lower income, and less human capital in adulthood (Macmillan 2000). Childhood exposure to abuse has been found to be associated with dissociation, limbic irritability, depression, and anger-hostility (Teicher et al. 2006), all of which may make it more difficult to attain higher education and maintain employment. Exposure to abuse or adult depression or substance abuse in the home, for example, may produce negative models for interpersonal communication, which could then be incorporated as a behavioral response in adult settings, such as college and the workplace. In addition, these negative behavioral models may translate into criminal justice involvement, such as arrest and conviction (Baglivio et al. 2014; Hagan and McCarthy 1997; Widom 1989), which can diminish future educational and employment prospects.

Research demonstrates that children who grow up in unhealthy, unsafe, or unstable environments are more likely to be economically disadvantaged as adults, *despite parental SES*. In a prospective cohort study using court-substantiated cases of childhood physical and sexual abuse, Currie and Widom (2010) found that adults with documented histories of childhood abuse and/or neglect had lower levels of education, employment, and earnings and fewer assets as adults compared with matched control children. Using longitudinal data and controlling for parental family structure and childhood SES, Covey et al. (2013) found significant associations between childhood physical abuse and witnessing adult domestic violence and adult income and net worth. Together, these economic disadvantages that are more prevalent among adults with ACEs may equate to worse health outcomes.

Adult SES is an established fundamental cause of health disparities because SES embodies a diverse collection of resources, such as money, knowledge, prestige, power, and important social connections that protect health (Adler et al. 1994; Link and Phelan 1995). SES differences exist for premature mortality (Idler and Benyamini 1997) and for almost every known disease and condition, including self-rated health (Laaksonen et al. 2005; Lantz et al. 2005), chronic conditions (House 1990) and disability (Hemingway et al. 1997; Lantz et al. 2005). Adults with higher SES should have greater access to financial resources, knowledge, and social networks that can protect against negative health conditions that may be linked to their adverse childhood experiences.

Unhealthy Lifestyle Behaviors—Previous research suggests that survivors of ACEs experience greater perceived stress as adults compared with adults who did not experience adverse events as a child (Briere and Elliott 2003; Hyman et al. 2007). As a result, these individuals may have developed adaptive coping strategies that are harmful to their health.

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Adults with ACEs may attempt to manage psychological problems, like stress, through avoidance-focused coping mechanisms that may be adaptive means of coping with trauma but may be detrimental to health in the long term. Coping strategies like smoking, alcohol consumption, over-eating, and engaging in risky behaviors can temporarily alleviate distress, shame, and helplessness (Briere 2002) but can lead to health problems over time. Meanwhile, healthier coping mechanisms, like exercise, may be underutilized as adaptive strategies to deal with the childhood trauma.

A number of unhealthy lifestyle choices have been linked to growing up in adverse household conditions. Researchers have found higher rates of adult smoking, drug abuse, physical inactivity, poor diet, alcoholism, and risky sexual behaviors among individuals who experienced childhood maltreatment or household dysfunction (Dube et al. 2003; Felitti et al. 1998; Ford et al. 2011; Kendall-Tackett et al. 2000). Ultimately, individuals' self-regulatory processes may be important intervening variables through which ACEs contribute to poor adult health.

The Present Study—This study advances the literature on the relationship between ACEs and adult health in several ways. First, while previous studies have been restricted to specific US states or community-based samples, we use a large sample of adults who provided retrospective information about their childhood experiences and current health status. Second, previous research on ACEs and adult health has often failed to control for health care access, risking potential confounding of physical health factors with access to care. By controlling for health insurance status we reduce this risk. Third, previous research has tended to examine one ACE at a time or created a cumulative index of experiences, thereby reducing our ability to be able to identify the unique association of each ACE with adult health, net of controls for other ACEs. Our research examines all of these associations while simultaneously controlling for each of the other ACEs in order to isolate the relationship of each ACE with adult health without risking the confounding that may occur when only examining one adverse condition at a time. Fourth, we use four distinct measures of health to explore whether ACEs differentially predict different adult health outcomes. Finally, we test two plausible pathways that may link ACEs to health, including adult SES, which is often neglected in studies examining relationships between ACEs and adult health despite it being an established fundamental cause of health disparities (Link and Phelan 1995).

METHODS

Data

We use data from the 2009–2012 Behavioral Risk Factor Surveillance System (BRFSS), an annual cross-sectional telephone survey conducted by the Centers for Disease Control (CDC) and U.S. states to collect information on health outcomes and behaviors, health care utilization, and demographic characteristics among the civilian, non-institutionalized population. One adult per household is randomly selected for the interview. In 2009–2012 questions about ACEs were available in an optional module for states. Over the four years, fourteen states incorporated the ACE module into their surveys: Arkansas and Louisiana

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(2009); Hawaii, Nevada, Vermont, Wisconsin, and the District of Columbia (2010); Minnesota, Montana, Vermont, Washington, and Wisconsin (2011); and Iowa, North Carolina, Oklahoma, Tennessee, and Wisconsin (2012). The core questions and ACE module questions were identical for all fourteen states over the four years, which enabled pooling the data for robust analysis. Because not all states participated in using the optional module, this sample of states underrepresents certain demographic groups, including Hispanics, metropolitan residents, and high-income households. To the extent that any of these groups are more or less likely to experience adverse events and poor health, our results could be upwardly or downwardly biased. A table showing differences in characteristics among respondents in states with vs. without the ACE module is available from the authors upon request. We will discuss the implications of these differences at the end of the paper. Because some states are represented in our sample more than once, and to control for variation in respondent characteristics across states, we include state fixed effects in our regression models.

Our analytic sample includes 52,250 adults aged 18–64. We restrict the sample in this way because it covers individuals in early adulthood and midlife when the onset of health problems and disparities are thought to be at their greatest (House et al. 1994; O'Rand and Hamil-Luker 2005).

Measures

Adult health—We examine four adult health outcomes: *self-rated health*, the presence of a *functional limitation, diabetes,* and experiencing *a heart attack.*. For self-rated health, respondents were asked: "Would you say that in general your health is: excellent, very good, good, fair, or poor?" We maintained the variable in its ordinal scale for our analyses. Functional limitation was measured with a binary question asking respondents to indicate whether they were "limited in any activities because of physical, mental, or emotional problems". For diabetes, respondents were asked if they had ever been told by a doctor, nurse, or other health care professional that they had diabetes. For heart attack, respondent were asked if they had ever been told by a doctor, nurse, or other health care professional that they had a heart attack or myocardial infarction. Both variables were dichotomous.

Adverse Childhood Experiences—The ACE module included eleven questions addressing adverse experiences related to a parent or another adult. The wording for each question is available from the authors upon request and can also be obtained via the BRFSS codebook on the BRFSS website. The first five items are dichotomous: divorce, depression, alcoholism, drug abuse, and incarceration. The six remaining questions asked respondents about the frequency of physical, verbal, and sexual abuse, with the options of: never, once, or more than once. Physical and verbal abuse were dummy coded (1 = more than once, 0 = one time or never) because even though all abuse, even that occurring only once, has potentially negative outcomes for children, abuse that occurs more than once is more representative of a pattern of adverse experiences in the home. We also ran regression models where we dichotomized the physical and verbal abuse outcomes as at least one instance vs. no instances, and the results were largely consistent. Due to strong correlations among the three sexual abuse items, we combined them to create one dummy variable

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indicating whether the respondent had experienced *at least one* form of sexual abuse during childhood because unlike physical or verbal abuse, a one-time sexual assault may have a much stronger effect on enduring health conditions. Again, we reran the models with the alternate outcome coding (more than once vs. once or none), and the model results were consistent.

Current Socioeconomic Status—Adult SES is measured with four indicators. Dummy variables capture categories of *total household income*: less than $25,000, $25,000–49,999, $50,000–74,999, and $75,000 or more (reference category); *educational attainment*: less than high school, high school graduate/some college, and 4-year college graduate (reference category); *employment status*: employed (reference category), unemployed, retired, student, and unable to work; and having any kind of *health care coverage* (the BRFSS does not specify type of coverage).

Health and Health Behaviors—Dummy variables capture *smoking status*: current, former, and never smoked (reference category); *binge drinking*: males having five or more and females having four or more drinks on one occasion in the past month; *exercise*: participating in any physical activity or exercise in the past month; *weight status*: obese (BMI or 30 or higher), overweight (BMI of more than 25 but less than 30), and neither overweight or obese (reference category); and *HIV risk behaviors* where respondents indicated whether they had engaged in any of the following in the past year (without specifying which): used intravenous drugs, treated for a sexually transmitted or venereal disease, given or received money or drugs in exchange for sex, or had anal sex without a condom. The literature suggests that stress, depression, and mental illness are common outcomes of ACEs (Hyman et al. 2007), and poor mental health is often what leads to poor health behavior choices (Ford et al. 2011). Accordingly, we included an indicator of respondent's mental condition (*mental*) with an item that asked: "Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?" The variable was not normally distributed and the median was 0, so we dichotomized it with those at or above the 75th percentile (3 days) coded 1 and those below the 75th percentile coded 0. Model results were robust to different variable specifications.

Controls—We controlled for a variety of potential confounders that have been found to be associated with ACEs and adult health in previous research: sex, race/ethnicity, age, age-squared, marital status, presence of children in the household, number of people living in the household, whether the respondent received a routine physical health checkup in the past two years, metropolitan status, and state fixed effects. Unfortunately, the BRFSS does not include any questions about conditions or characteristics during childhood, except the ACEs. Therefore, we were unable to control for parental SES, other childhood characteristics, or the timing of the ACEs. Due to space constraints, we do not present the regression coefficients of our control variables for any of the models, but they are available from the authors upon request.

To assess the potential of multicollinearity, we requested and checked multicollinearity diagnostics for all models, using the variance inflation factor (VIF) and tolerance (TOL).

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The tolerance values for all variables were well above .20 for all models (range .40–.96) and the VIF values were all under 2.2 (Allison suggests 2.5 as a safe cut-off), except for the state fixed effects, but this is to be expected and can be safely ignored given that they are categories of the same variable (Allison 2012). Therefore, we are not worried about multicollinearity in any of our models.

Analytic Strategy

We present descriptive statistics in Table 1 for all variables for the full sample and comparing adults who experienced at least one ACE vs. adults who did not experience any of the nine ACEs. Although we recognize that not all of the ACEs are equal in their frequency or impact on individuals, this is the most efficient way to display these statistics.

We estimate the relationships between ACEs and adult self-rated health with ordinal logistic regression models. These models estimate the cumulative probability of being at or below a particular category of self-rated health (in this case, the probability of having better health). Cumulative logit plots identified no concerns with violating the proportional odds assumption. We then estimate the relationships between the ACEs and the presence of a functional limitation, diabetes, and heart attack using binary logistic regression models.

For each adult health outcome, we first present Model 1 that includes all of the ACEs and the control variables discussed above. Model 2 includes SES indicators. Finally, Model 3 integrates mental health and health behaviors. All analyses are weighted with the BRFSS individual survey weight to adjust for sampling, nonresponse, and telephone coverage bias. To formally test the hypotheses that adult SES and health behaviors mediate associations between ACEs and adult health, we checked for statistically significant declines in the coefficients (logged odds) for our ACEs with and without the additional variables in the model using the KHB method in Stata (Karlson et al. 2012; Karlson and Holm 2011; Kohler et al. 2011). The estimated coefficients from Model 1 (demographic control model) were compared with the estimated coefficients from Model 2 (SES model) to determine whether adult SES mediated the effects of the ACE variables. Then, the estimated coefficients from Model 2 were compared with those from Model 3 (health behaviors model) to determine whether poor mental health and health behaviors additionally mediated the associations of the ACE variables with adult health. Results of the mediation tests for all outcomes are presented in Table 4. Due to space constraints, we do not present the coefficients from our SES and health behavior variables for all models. Instead, we present a final table (Table 5) that displays the coefficients for those variables from just the final models for each of our outcomes, and we discuss variation in the associations between each of the health outcomes and our SES and health behavior variables at the end of the Results section.

Sample Characteristics

The total number of respondents aged 18–64 from states that included the adverse childhood experiences module over the four-year period was 62,370. After deletion of cases with missing responses on the variables of interest, our final analytic sample included 52,250 adults aged 18–64. There were no significant differences between these respondents and those who were excluded due to missing responses.

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RESULTS

Table 1 displays descriptive statistics for all variables included in the analysis. Just over half (58%) of respondents indicated that they had experienced at least one of the nine ACEs. The most common ACE was verbal abuse (29%), followed by living with an alcoholic and experiencing parental divorce (25% each). The least common ACE was living with someone who had been incarcerated (7%). About 21% of adults reported excellent health, 37% reported very good health, 29% reported good health, and 10% and 4% reported fair and poor health, respectively. Nearly one-fifth of respondents indicated that their activities were limited by some physical, emotional, or mental problem. Just over 7% of the sample reported having a diabetes diagnosis, and 2.7% reported having a heart attack.

Table 1 also demonstrates sharp differences in health status and respondent characteristics between individuals who experienced any ACE vs. those who did not. Adults who experienced at least one ACE reported worse health, were more likely to report a functional limitation, and were significantly more likely to report a diagnosis of diabetes or heart attack than respondents who did not report an ACE. Compared to those who reported no ACEs, adults who reported a ACE were more likely to be female, non-white, divorced, separated or never married, have children living in the household, be unemployed, have lower household incomes and educational attainment, be current or former smokers, obese, binge drinkers, and have engaged in HIV risk behaviors in the past year. Adults who experienced ACEs were less likely than those who did not to have a routine physical health checkup in the past 2 years, have health insurance, report exercising in the past month, and live in a non-metro area.

The Relationship between Adverse Childhood Experiences and Adult Self-Rated Health and Functional Limitations

We examine associations between ACEs and self-rated health and ACEs and the presence of a functional limitation in Table 2. We present the results of these outcomes together because they both represent self-evaluated health conditions, while our other two variables – diabetes and heart attack – represent physician diagnoses. In Model 1 for self-rated health, experiencing childhood physical, verbal, or sexual abuse, living with someone who was depressed or abused alcohol, and experiencing parental divorce were significantly associated with worse self-rated health, net of controlling for each other and for various demographic characteristics. Although the effect sizes for the significant ACEs are fairly robust (e.g., respondents who reported physical abuse have about 24% lower odds of being in a better health category), the fit statistics at the bottom of the table (Pseudo-R^2 and c) indicate that we have omitted variables that are important for predicting self-rated health.

The introduction of socioeconomic covariates in Model 2 results in the elimination of the significance of parental divorce on self-rated health and also significantly mediates associations between physical abuse, sexual abuse, and living with an alcoholic and self-rated health. As indicated by the mediation analysis (Table 4), the inclusion of SES led to a significant reduction in the effects of physical abuse on self-rated health by 60%, sexual abuse by 50%, living with an alcoholic by 43%, and parental divorce by 86%. In supplemental analysis, not presented due to space constraints but available from authors

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upon request, we found that household income and education explained all of the reduction in the magnitude of the coefficients for living with an alcoholic and parental divorce, and the combination of income, education, and employment status explained all of the reduction in the magnitude of the coefficients for physical and sexual abuse. Health insurance did not contribute to the mediation of any of the ACEs.

Adding mental health problems and stress-related health coping behaviors in Model 3 resulted in additional attenuation for physical abuse by 52%, verbal abuse by 36%, sexual abuse by 89%, living with a depressed person by 51%, and living with an alcoholic by 38%. Supplemental analyses indicated that the Model 2 to Model 3 reduction in magnitude of the coefficient for living with someone who was depressed was entirely explained by the introduction of respondent's own poor mental health, suggesting an intergenerational transmission of depression. The reduction of the magnitudes of physical, verbal, and sexual abuse and living with someone who was an alcoholic was due to the combination of poor mental health, smoking, and weight status. Net of all controls, only childhood verbal abuse remained a significant predictor of adult self-rated health; respondents who reported more than one instance of verbal abuse in childhood have significantly worse self-rated health than respondents who reported only one or no instances of childhood verbal abuse.

The results of the analyses examining the associations between ACEs and odds of having a mental, emotional, or physical limitation to participation in activities are displayed in the lower half of Table 2. As shown in Model 1, only witnessing parental domestic violence was not significantly associated with odds of a functional limitation. Experiencing each of the other conditions was associated with between 13% and 56% greater odds of having a functional limitation. The introduction of adult SES in Model 2 significantly mediated the associations for physical abuse by almost half, sexual abuse by 37%, living with someone who was depressed by 15%, living with someone who abused alcohol by 33%, living with someone who was incarcerated by 107%, and parental divorce by 32%, but not verbal abuse or living with someone who abused drugs. Our supplemental analyses revealed that household income alone explained all of the mediation for living with someone who abused alcohol and parental divorce, and income, education, and employment status explained the mediation for physical and sexual abuse and living with someone who was depressed or who had been incarcerated.

The introduction of health behaviors in Model 3 further attenuated the associations for physical, verbal, and sexual abuse by between 16% and 43%, living with someone who was depressed by 20%, and living with someone who abused alcohol by 32%. Our supplemental analysis revealed that respondent's poor mental health alone accounted for these mediations for physical and verbal abuse and for living with someone who was depressed or abused alcohol. The combination of all but HIV risk behaviors explained the significant mediation for sexual abuse. Net of all controls, respondents who experienced verbal or sexual abuse in childhood or who lived with a depressed person have significantly greater odds of reporting a functional limitation in adulthood.

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The Relationship between Adverse Childhood Experiences and Diabetes and Heart Attack

The results of the analyses examining the relationships between ACEs and the two chronic diseases (diabetes and heart attack) are presented in Table 3. Looking at the diabetes models first (Model 1), respondents who reported physical or sexual abuse or domestic violence had about 23%, 36%, and 22% greater odds respectively of being diagnosed with diabetes than respondents who did not report those events. The introduction of adult SES in Model 2 significantly attenuated the associations between physical abuse and diabetes by 47% and between domestic violence and diabetes by 30% (see Table 4), and our supplemental analyses demonstrated that household income, educational attainment, and employment status, but not health insurance, contributed to the mediation for both associations. Although the effects of sexual abuse were partially attenuated (by 24%), sexual abuse remained significantly associated with increased odds of a diabetes diagnosis. The introduction of adult health behaviors in Model 3 further attenuated the association with sexual abuse (by 50%), and this was explained entirely by the introduction of poor mental health and weight status.

The heart attack models are presented in the bottom half of Table 3. Respondents who experienced physical abuse or parental divorce or who lived with some who abused drugs or had been incarcerated all had significantly and substantively greater odds of reporting a heart attack (Model 1). When adult SES was added to the model (Model 2), the significance for living with someone who had been incarcerated was eliminated, the association between physical abuse and heart attack was mediated by 24%, and the association between parental divorce and heart attack was mediated by 25% (see Table 4). These reductions in the magnitude of coefficients were again explained by household income, educational attainment, and employment status, but not health insurance. The addition of SES variables also did not significantly mediate the positive association between living with someone who abused drugs and odds of having a heart attack. Finally, the addition of mental health and health behaviors in Model 3 (but no one variable in particular) explained the remaining association between living with someone who abused drugs and heart attack, and only slightly attenuated the association between physical abuse and heart attack (by 12%). However, physical abuse remained significant, and health behaviors did not significantly mediate the positive association between parental divorce and heart attack. Thus, among respondents with similar demographic, SES, and health behavior characteristics, odds of having a heart attack are greater among respondents who reported childhood physical abuse and parental divorce than among adults who did not have those experiences as children.

Finally, we present the coefficients from our final models (Model 3) for all four of our outcomes in Table 5 as a way to compare which SES and health behavior variables were associated with each of the health outcomes. The odds ratios for the ACEs are carried down from Model 3 from each of their respective tables. In terms of SES, we find that compared with respondents with household incomes of $75,000 or more, those with incomes below $75,000 had worse self-rated health and greater odds of diabetes, and those with incomes below $50,000 had greater odds of a functional limitation. However, it was only the lowest income respondents (those with household incomes of less than $25,000) that were at increased risk of a heart attack. The associations for employment status were heterogeneous

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across the four outcomes; compared to those who were employed, those who were retired or unable to work had worse self-rated health, those who were unemployed, retired or unable to work had greater odds of diabetes, all categories of unemployed had greater odds of a functional limitation, and all categories of unemployed except being a homemaker had greater odds of a heart attack. For educational attainment, compared to those with a four-year college degree, those with less than high school or a high school diploma had worse self-rated health and greater odds of a heart attack, but only those with less than a high school diploma had greater odds of diabetes. Interestingly, those without a college degree had lower odds of a functional limitation than those with a college degree. Finally, having health insurance was associated with better self-rated health but also greater odds of having a functional limitation, and as discussed earlier, was not a mediator of the associations between ACEs and any health outcomes.

In terms of health behaviors, being a current or former smoker was associated with worse health and with greater odds of a functional limitation and a heart attack, but not diabetes. Being overweight or obese was associated with worse self-rated health, and increased odds of a functional limitation, diabetes, and heart attack, and exercise was associated with better self-rated health and inversely associated with a functional limitation, diabetes, and heart attack. Binge drinking was associated with better self-rated health and lower odds of a functional limitation and diabetes. Finally, HIV risk behavior was associated only with increased odds of having a heart attack.

Discussion

We used data from the four years in which the *adverse childhood experiences* module was available (2009–2012) in the Behavioral Risk Factor Surveillance System (BRFSS) to examine associations between adverse experiences during childhood and adult physical health and to explore plausible explanations for how these experiences may be connected to poor adult physical health. The results of this study highlight the importance of family-based ACEs on adult health outcomes and suggest that adult SES and stress-related coping behaviors are crucial links between trauma in the childhood home and adult health.

This research advances the literatures on ACEs and life course determinants of health in a number of important ways. First, findings indicate that, net of controls for concomitant ACEs and demographic characteristics of respondents, there are several important associations between adverse conditions in childhood and all four indicators of adult health. While previous research has examined relationships between adult health and one particular adverse experience at a time or combined ACEs into a single summed construct, by integrating all nine adverse experiences into the same analyses, we were able to reduce the risk of confounding that occurs when excluding potentially concomitant experiences while at the same time maintaining the ability to delineate the unique health outcomes associated with each type of adverse experience. This is important because we found that the associations between ACEs and adult health were not universal; some ACEs were associated with certain health outcomes but not others. For example, experiencing childhood physical abuse was significantly and substantively associated with all four health outcomes while verbal abuse was associated only with self-rated health and functional limitations and

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witnessing parental domestic violence was associated only with odds of a diabetes diagnosis. Combining the ACEs into a cumulative scale would mask these variations.

Second, our results largely support the hypothesis that adult SES helps to explain the relationship between ACEs and physical health outcomes. This is important considering that a large proportion of previous research on the relationship between ACEs and adult health downplays or completely ignores the role of adult SES. Formal statistical mediation analyses revealed that SES, particularly household income and educational attainment, significantly mediate associations between all four health outcomes and most of the ACEs. Children who grow up in unsafe and unhealthy environments may be at greater risk of rejecting social norms related to socioeconomic success or of having lowered expectations or ambitions for SES attainment (Agnew 1999; Covey et al. 2013; Merton 1938). Given the well-established role of SES as a social determinant of health (Link and Phelan 1995) adult economic disadvantage stemming from adverse conditions during childhood may then result in worse health outcomes in adulthood. A limitation to this study is that we were unable to control for childhood SES, which has been found in previous research to be associated both with adult SES and adult health (Hayward and Gorman 2004; Montez and Hayward 2014), leading to potential confounding in our results. Therefore, although the association between childhood adversity and adult health does appear to be at least partially explained by adult SES, this association is not independent of childhood SES. However, given recent findings that children who experienced abuse or neglect had lower SES in adulthood regardless of parental SES during childhood (Covey et al. 2013; Currie and Widom 2010), we are confident that our results would be robust to controls for childhood SES if they were available. Interestingly, despite the importance of health insurance in enabling access to health care resources and our finding that individuals who had no ACEs were more likely to have health insurance than those who had at least one ACE, we found that health insurance did not serve as a mediator between any of the ACEs and any health outcomes. Future research should more fully examine the role of insurance coverage in minimizing the impacts of trauma and stress on health throughout the life course. Rather than trying to reduce disease burden with health care system treatment, more effective strategies may include the promotion of positive coping behaviors and strategies to improve mental health.

Indeed, we found that poor mental health and poor stress-related coping behaviors, such as smoking, obesity, and lack of exercise were more prevalent among adults who experienced ACEs, and these behaviors and conditions helped to attenuate relationships between ACEs and adult health. Poor mental health was particularly important in explaining associations between ACEs and the health outcomes. For example, the remaining associations between functional limitations and physical abuse, verbal abuse, living with someone who was depressed, and living with someone who abused alcohol were explained with the introduction of poor mental health. These findings support the vast literature suggesting that individuals who experienced adverse childhood conditions often develop adaptive coping strategies to deal with symptoms of depression and stress that are harmful to their health (Briere 2002; Dube et al. 2003; Felitti et al. 1998; Ford et al. 2011; Kendall-Tackett et al. 2000).

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The results of this study also support and extend previous research suggesting that psychological maltreatment may be just as or more detrimental to health than physical abuse (Irving and Ferraro 2006; Teicher et al 2006). Even after all controls, childhood verbal abuse remained a robust and enduring predictor of self-rated health and functional limitations, while physical abuse only remained associated with odds of having a heart attack, and sexual abuse only remained associated with odds of having a functional limitation. It is interesting that the enduring relationships between verbal abuse and adult health existed for the two items that were self-rated by respondents rather than the disease diagnoses items. Childhood verbal abuse may have a more enduring effect on individuals' *perceptions* of their own health. Future research should explore the mechanisms that link childhood verbal abuse to adult perceptions of health in an effort to propose interventions to reduce the lifelong burden of childhood verbal abuse.

Parental divorce also remained significantly and positively associated with odds of having a heart attack, net of all controls.. Previous research suggests that parental divorce can be stressful to children's developmental processes (Amato 2010). The disadvantaged circumstances that often occur for families before, during, and after divorce may influence risk of cardiovascular problems later in life in ways that we were unable to capture with the existing health behavior variables in the BRFSS. For example, the BRFSS item about exercise asks only whether the respondent engaged in any form of exercise, with no indication of frequency, amount, or energy expenditure, and the weight status variable uses the controversial proxy of body mass index which may not accurately capture obesity and obesogenic outcomes like heart disease and heart attack. Our measure of divorce is also unable to capture the overall family structure of respondents when they were children, including whether children were exposed to multiple divorces or other family transitions or whether the divorce improved or worsened living conditions for the child.

Although not the primary purpose of this study, we did find that certain SES and health history and behavior variables were more important for explaining some adult health outcomes than others. For instance, weight status was a particularly important predictor of diabetes; poor mental health and being unable to work were most strongly associated with having a functional limitation; exercise was a strong predictor of self-rated health, and weight status and smoking were strongly associated with heart attack. There were also some interesting findings related to SES. While individuals with household incomes of less than $75,000 had worse self-rated health and higher odds of diabetes than those with incomes of $75,000 or more, only the lowest income individuals (those with poverty incomes of $25,000 or less) had increased odds of a heart attack, and those with less than a high school diploma had over twice the odds of a heart attack than those with a college degree, suggesting that being in a precarious socioeconomic position puts one at particular risk of cardiovascular troubles. Unfortunately, we are unable to control for important indicators like fat and sugar consumption, energy expenditure, and cortisol levels that may explain this elevated risk of heart attack among socioeconomically disadvantaged individuals. Explanations of these phenomena are beyond the scope of this paper, but researchers should continue to examine the existence and strength of associations between various adult health

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outcomes and indicators of SES and health behaviors and not simply assume that those relationships are universal across all health outcomes.

A number of limitations should be considered when interpreting the results of this research. First, this study cannot account for childhood health and other conditions, which may confound the findings. It is possible that having a child with health problems may lead to marital problems and parental frustration that may increase the risk for physical and verbal abuse, parental depression, substance abuse, and divorce. Second, the effects of ACEs on adult health are likely conditioned by the age at which the child experienced the adversity (Elder 1994; Macmillan 2001) as well as the duration and severity of the adversity. Due to the retrospective nature of these data, we were unable to assess variation in timing, duration, and severity of ACEs. Instances of abuse that occurred many decades in the past may alter respondents' interpretation of events, and this in turn may bias our results. This is particularly important for verbal abuse since it is a far more ambiguous construct than the other ACEs, and it may be that those who are in poor health, and are therefore more pessimistic about their futures, retroactively interpret occasions of disagreement or discipline as more abusive than people who are in good health. It may also be that adults who interpret their current and retrospective life conditions in more negative terms are more likely to report both childhood verbal abuse and poor health.

Third, there are many different ways to measure health, and even though we have examined three distinct measures, a comprehensive health measure may more accurately represent an individual's health (Richardson and Zumbo 2000; Wolinsky and Zusman 1980). Similarly, the functional limitation dependent variable is measured with a binary 'yes/no' response in the BRFSS. A scale or index of functional limitations would allow for a more nuanced examination of the relationship between ACEs and functional limitations. Fourth, data limitations may lead to omitted variable bias, in this case related to the omission of other childhood adversities like household poverty, poor nutrition, residential instability, and dangerous neighborhood conditions.

Finally, due to the voluntary uptake of the ACE module in the BRFSS, this sample is not nationally representative. The states that included this module had lower percentages of Hispanics on average than the US as a whole. Given that Hispanics in our sample were more likely than whites to have reported ACEs, worse self-rated health, and higher chronic disease prevalence, the most likely consequence of the under-representation of Hispanics in our sample is that our results underestimate the prevalence of ACEs in the US.

Despite these limitations, this research extends previous research about the consequences of ACEs in the family environment on well-being into adulthood by examining the relationships between nine different ACEs and three different physical health outcomes, while controlling for the potential confounding effect of experiencing multiple adverse conditions during childhood. We were also able to demonstrate that the pathways linking ACEs to adult health vary across the type of adverse experience being considered.

Childhood is a period in the life course that has major implications for future educational, labor market, and health outcomes (Macmillan 2001; McLeod and Kaiser 2004). To the

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extent that ACEs are associated with poor health outcomes in adulthood, they should be considered life course social determinants of health and an issue deserving of public health attention. Given that ACEs may subject children to disadvantaged socioeconomic and health life-course trajectories, early interventions with unstable or abusive parents may be one of several strategies to prevent future SES disparities *and* health disparities. Interventions targeting the early childhood origins of adult health disparities may be more effective than attempting to modify health behaviors or improve health care access in adulthood (Shonkoff et al. 2009). Finally, while child protective service agencies and doctors have historically been more concerned about the impact and prevention of physical and sexual abuse (Manning and Cheers 1995), the results of this study suggest that screening for verbal abuse should also be a priority.

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Table 1

Percentages or Means(SD) for Variables included in the Analysis for Entire Sample and by Experience of Adverse Childhood Experience

	Sample (N=52,250)	Any Adverse (N=30,563)	No Adverse (N=21,687)	
Physical abuse	12.0	------	------	
Verbal abuse	29.1	------	------	
Sexual abuse	11.6	------	------	
Domestic violence	12.5	------	------	
Depression	17.7	------	------	
Alcohol Abuse	25.2	------	------	
Drug Abuse	11.2	------	------	
Incarceration	6.9	------	------	
Parental divorce	25.2	------	------	
Health Outcomes				
Self-rated health				
Excellent	20.9	18.8	23.9	***
Very Good	36.7	34.7	39.4	***
Good	29.0	30.4	27.1	***
Fair	9.8	11.7	7.2	***
Poor	3.6	4.5	2.5	***
Functional Limitation	19.0	23.3	13.0	***
Diabetes	7.4	7.9	6.8	***
Heart Attack	2.7	3.0	2.2	***
Demographic Characteristics				
Sex (Female)	50.3	52.6	47.2	***
Age	43.9 (12.55)	43.2 (12.29)	44.9 (12.85)	***
Race/Ethnicity				
Non-Hispanic White	79.3	78.4	80.5	***
Non-Hispanic Black	8.9	9.9	7.5	***
Hispanic	4.5	4.8	4.0	***
Non-Hispanic Other Race	7.4	6.9	8.0	***
Marital Status				
Married	64.9	61.5	69.6	***
Divorced/Separated	11.3	13.2	8.7	***
Widowed	2.0	2.0	2.0	
Never Married	21.8	23.3	19.7	***
Children in the household (Yes)	46.6	47.9	44.8	***
Number of people in household	3.2 (1.54)	3.2 (1.54)	3.2 (1.56)	
Lives in Non-Metro area	30.1	29.1	31.6	***
Had a routine health checkup in past 2 years	80.7	79.8	81.9	***
Socioeconomic Status				
Household income				

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	Sample (N=52,250)	Any Adverse (N=30,563)	No Adverse (N=21,687)	
Less than $25,000	20.6	23.8	16.2	***
$25,000–49,999	25.4	25.6	25.1	
$50,000–74,999	18.9	18.5	19.4	**
$75,000+	35.1	32.1	39.3	***
Employment status				
Employed	70.8	68.8	73.7	***
Unemployed	13.3	8.9	16.5	***
Homemaker	6.3	6.4	6.3	
Student	3.9	4.0	3.8	
Retired	56.1	4.6	7.1	***
Unable to work	6.0	7.4	4.2	***
Education				
Less than high school	7.2	8.4	5.6	***
High school grad/some college	59.8	62.1	56.7	***
College grad	32.9	29.5	37.7	***
Has health insurance	85.3	83.5	87.8	***
Health History and Behaviors				
Poor mental health	24.9	31.0	16.7	***
Smoking status				
Never smoked	55.6	48.9	64.7	***
Former smoker	24.0	25.8	21.5	***
Current smoker	20.4	25.3	13.8	***
Weight status				
Not overweight or obese	34.0	33.4	34.8	**
Overweight	35.3	34.1	36.9	***
Obese	30.7	32.5	28.3	***
Binge drinker	19.6	21.1	17.5	***
Exercise	78.9	77.6	80.7	***
HIV risk behaviors	2.8	3.7	1.4	***

Note: ‘Any adverse’ indicates that the respondent experienced at least one of the nine adverse conditions in childhood; Independent samples t-tests for difference of means/percentages;

** p<.01,

*** p<.001; weighted values

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Sociol Q. Author manuscript; available in PMC 2015 October 23.

Table 2

Odds Ratios and 95% Confidence Intervals from Ordinal Logistic Regression Models for Self-Rated Health and Binary Logistic Regression Models for Functional Limitation

SELF-RATED HEALTH	**Model 1**[a]		**Model 2**[b]		**Model 3**[c]	
Physical abuse	0.762***	0.682–0.852	0.891*	0.795–0.999	0.944	0.840–1.062
Verbal abuse	0.838***	0.776–0.904	0.795***	0.735–0.860	0.855***	0.789–0.926
Sexual abuse	0.756***	0.688–0.831	0.851***	0.775–0.935	0.981	0.893–1.077
Domestic violence	1.016	0.916–1.126	1.108	1.000–1.227	1.089	0.980–1.209
Depression	0.863**	0.791–0.940	0.865***	0.792–0.945	0.925	0.848–1.010
Alcohol Abuse	0.853***	0.790–0.921	0.906*	0.839–0.979	0.937	0.867–1.013
Drug Abuse	0.900	0.803–1.009	0.915	0.817–1.026	0.921	0.821–1.035
Incarceration	0.892	0.770–1.034	1.119	0.964–1.299	1.151	0.991–1.336
Parental divorce	0.887***	0.823–0.957	0.982	0.910–1.060	1.007	0.933–1.097
Intercept - Excellent	0.305**	(.114)	0.775***	(.125)	−0.122	(.128)
Intercept - Very Good	2.029***	(.114)	2.607***	(.126)	1.846***	(.129)
Intercept - Good	3.686***	(.115)	4.517***	(.127)	3.889***	(.130)
Intercept - Fair	5.149***	(.117)	6.285***	(.129)	5.731***	(.132)
Intercept - Poor (REF)	------		------		------	
AIC	142056.88		133580.90		128235.15	
c^d	.629		.697		.745	
Pseudo-R^2	.088		.234		.315	

FUNCTIONAL LIMITATION	**Model 1**[a]		**Model 2**[b]		**Model 3**[c]	
Physical abuse	1.323***	1.168–1.148	1.168*	1.012–1.350	1.110	0.958–1.285
Verbal abuse	1.485***	1.350–1.632	1.632***	1.468–1.814	1.513***	1.358–1.686
Sexual abuse	1.511***	1.362–1.676	1.344***	1.196–1.510	1.187**	1.051–1.340
Domestic violence	0.988	0.873–1.118	0.920	0.796–1.063	0.937	0.808–1.086
Depression	1.564***	1.413–1.732	1.537***	1.371–1.722	1.418***	1.262–1.594
Alcohol Abuse	1.158**	1.055–1.270	1.113*	1.004–1.234	1.080	0.972–1.201

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FUNCTIONAL LIMITATION	Model 1[a]		Model 2[b]		Model 3[c]	
Drug Abuse	1.163*	1.019–1.328	1.180*	1.016–1.372	1.161	0.955–1.355
Incarceration	1.184*	1.008–1.391	0.988	0.821–1.190	0.992	0.822–1.197
Parental divorce	1.127*	1.023–1.241	1.093	0.982–1.216	1.098	0.986–1.223
Intercept	−4.774***	(.186)	−5.295***	(.219)	−4.807***	(.226)
AIC	45909.08		39701.31		38156.20	
c[d]	.701		.777		.799	
Pseudo-R^2	.097		.220		.251	

Note: Adjusted odds ratios and 95% confidence intervals reported;

* p<.05;

** p<.01,

*** p<.001

[a] Controls for gender, age, race/ethnicity, marital status, presence of children in the household, total number of people in the household, metropolitan status, receipt of routine physical health checkup in past 2 year, and state fixed effects;

[b] Adds adult SES;

[c] Adds mental health and stress-related coping behaviors;

[d] The c-statistic represents model goodness-of-fit. Models are considered reasonable when the c-statistic is greater than .700 (Hosmer and Lemeshow 2000).

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Table 3

Odds Ratios and 95% Confidence Intervals from Binary Logistic Regression Models for Diabetes and Heart Attack

DIABETES	Model 1[a]		Model 2[b]		Model 3[c]	
Physical abuse	1.231*	1.027–1.477	1.102	0.914–1.329	1.078	0.891–1.305
Verbal abuse	1.056	0.920–1.211	1.098	0.954–1.264	1.044	0.904–1.206
Sexual abuse	1.358***	1.166–1.581	1.259**	1.075–1.473	1.126	0.959–1.323
Domestic violence	1.*	1.016–1.454	1.147	0.954–1.380	1.182	0.979–1.427
Depression	1.018	0.882–1.175	1.009	0.869–1.171	0.967	0.827–1.131
Alcohol Abuse	0.989	0.865–1.131	0.951	0.828–1.092	0.933	0.810–1.075
Drug Abuse	0.846	0.685–1.044	0.829	0.666–1.032	0.862	0.690–1.077
Incarceration	1.246	0.968–1.604	1.052	0.814–1.360	1.078	0.833–1.396
Parental divorce	1.061	0.924–1.219	0.995	0.861–1.150	1.005	0.863–1.170
Intercept	−8.697***	(.368)	−8.773***	(.390)	−8.594***	(.408)
AIC	24518.47		23731.57		22010.07	
c[d]	.728		.759		.817	
Pseudo-R^2	.146		.181		.254	

HEART ATTACK	Model 1[a]		Model 2[b]		Model 3[c]	
Physical abuse	1.755***	1.374–2.242	1.489**	1.149–1.929	1.414**	1.090–1.833
Verbal abuse	0.961	0.772–1.197	1.021	0.814–1.280	0.977	0.778–1.227
Sexual abuse	1.076	0.836–1.384	0.947	0.732–1.224	0.858	0.664–1.108
Domestic violence	1.078	0.840–1.385	0.986	0.766–1.269	0.985	0.765–1.268
Depression	1.171	0.920–1.489	1.155	0.894–1.491	1.108	0.860–1.428
Alcohol Abuse	0.945	0.764–1.168	0.877	0.709–1.085	0.842	0.682–1.040
Drug Abuse	1.435*	1.030–1.998	1.425*	1.006–2.019	1.394	0.981–1.981
Incarceration	1.748*	1.116–2.737	1.372	0.858–2.192	1.377	0.862–2.200
Parental divorce	1.419**	1.110–1.823	1.290*	1.013–1.642	1.277*	1.004–1.624
Intercept	−8.246***	(.583)	−8.809***	(.622)	−8.619***	(.629)
AIC	11048.15		10325.63		10170.42	

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HEART ATTACK	Model 1[a]	Model 2[b]	Model 3[c]
c[d]	.776	.820	.834
Pseudo-R^2	.149	.207	.242

Note: Adjusted odds ratios and 95% confidence intervals reported from binary logistic regression models;

* p<.05;

** p<.01,

*** p<.001

[a] Controls for gender, age, race/ethnicity, marital status, presence of children in the household, total number of people in the household, metropolitan status, receipt of routine physical health checkup in past 2 year, and state fixed effects;

[b] Adds adult SES;

[c] Adds mental health and stress-related coping behaviors;

[d] The c-statistic represents model goodness-of-fit. Models are considered reasonable when the c-statistic is greater than .700 (Hosmer and Lemeshow 2000).

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Table 4

KHB Tests for Mediation

Self-Rated Health

	Model 1–Model 2			Model 2–Model 3		
	% change	**est. diff**	**SE diff**	**% change**	**est. diff**	**SE diff**
Physical abuse	60%	−0.175	(.024)	52%	−0.063	(.020)**
Verbal abuse	−20%	0.039	(.015)**	36%	−0.089	(.013)***
Sexual abuse	50%	−0.165	(.022)***	89%	−0.149	(.017)***
Domestic violence	−2793%	−0.099	(.023)***	24%	0.027	−0.018
Depression	10%	−0.016	−0.018	51%	−0.081	(.016)***
Alcohol Abuse	43%	−0.076	(.016)***	38%	−0.04	(.013)**
Drug Abuse	11%	−0.011	−0.024	16%	−0.015	−0.02
Incarceration	184%	−0.246	(.033)***	−18%	−0.021	−0.024
Parental divorce	86%	−0.111	(.016)***	155%	−0.02	−0.013

Functional Limitation

	Model 1–Model 2			Model 2–Model 3		
	% change	**est. diff**	**SE diff**	**% change**	**est. diff**	**SE diff**
Physical abuse	49%	0.152	(.027)***	37%	0.061	(.016)***
Verbal abuse	−4%	−0.018	−0.015	16%	0.078	(.011)***
Sexual abuse	37%	0.173	(.024)***	43%	0.132	(.015)***
Domestic violence	−444%	0.068	(.025)**	29%	−0.026	−0.014
Depression	15%	0.078	(.019)***	20%	0.087	(.013)***
Alcohol Abuse	33%	0.052	(.017)**	32%	0.036	(.011)**
Drug Abuse	−1%	−0.001	−0.024	15%	0.026	−0.016
Incarceration	107%	0.178	(.036)***	24%	−0.002	−0.02
Parental divorce	32%	0.041	(.017)*	10%	0.011	−0.011

Sociol Q. Author manuscript; available in PMC 2015 October 23.

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Diabetes

	Model 1–Model 2			Model 2–Model 3		
	% change	**est. diff**	**SE diff**	**% change**	**est. diff**	**SE diff**
Physical abuse	47%	0.087	(.013)***	35%	0.040	−0.023
Verbal abuse	−20%	−0.016	−0.009	56%	0.054	(.016)**
Sexual abuse	24%	0.074	(.122)***	50%	0.120	(.022)***
Domestic violence	30%	0.058	(.013)***	−12%	−0.018	−0.021
Depression	−35%	−0.002	−0.011	535%	0.041	(.019)*
Alcohol Abuse	−291%	0.037	(.010)***	14%	−0.011	−0.016
Drug Abuse	−9%	0.015	−0.014	23%	−0.045	−0.024
Incarceration	72%	0.134	(.020)***	15%	0.014	−0.03
Parental divorce	108%	0.073	(.012)***	144%	−0.017	−0.016

Heart Attack

	Model 1–Model 2			Model 2–Model 3		
	% change	**est. diff**	**SE diff**	**% change**	**est. diff**	**SE diff**
Physical abuse	24%	0.128	(.020)***	12%	0.048	(.014)**
Verbal abuse	276%	−0.032	(.013)*	162%	0.060	(.112)***
Sexual abuse	188%	0.117	(.017)***	−272%	0.112	(.018)***
Domestic violence	126%	0.069	(.019)***	59%	−0.022	−0.012
Depression	−6%	−0.008	−0.017	30%	0.043	(.014)**
Alcohol Abuse	−109%	0.068	(.014)***	−21%	0.030	(.011)**
Drug Abuse	2%	0.008	−0.019	10%	0.038	(.017)*
Incarceration	37%	0.183	(.030)***	6%	0.020	−0.018
Parental divorce	25%	0.085	(.019)***	7%	0.019	−0.012

Note: KHB tests for mediation in Stata; '% change' represents percentage change in log odds between two models; 'est. diff' represents difference in log odds between two models; 'SE diff' represents the standard error of the difference between the two models

* p<.05;

** p<.01;

*** p<.001

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Table 5

Odds Ratios and 95% Confidence Intervals from Final Models for all Outcomes

	Self-Rated Health		Functional Limitation		Diabetes		Heart Attack	
Adverse Childhood Experiences								
Physical abuse	0.944	0.840–1.062	1.110	0.958–1.285	1.078	0.891–1.305	1.414**	1.090–1.833
Verbal abuse	0.855***	0.789–0.926	1.513***	1.358–1.686	1.044	0.904–1.206	0.977	0.778–1.227
Sexual abuse	0.981	0.893–1.077	1.187**	1.051–1.340	1.126	0.959–1.323	0.858	0.664–1.108
Domestic violence	1.089	0.980–1.209	0.937	0.808–1.086	1.182	0.979–1.427	0.985	0.765–1.268
Live with depressed person	0.925	0.848–1.010	1.418***	1.262–1.594	0.967	0.827–1.131	1.108	0.860–1.428
Live with alcohol abuse	0.937	0.867–1.013	1.080	0.972–1.201	0.933	0.810–1.075	0.842	0.682–1.040
Live with drug abuse	0.921	0.821–1.035	1.161	0.955–1.355	0.862	0.690–1.077	1.394	0.981–1.981
Live with convicted offender	1.151	0.991–1.336	0.992	0.822–1.197	1.078	0.833–1.396	1.377	0.862–2.200
Parental divorce	1.007	0.933–1.097	1.098	0.986–1.223	1.005	0.863–1.170	1.277*	1.004–1.624
Socioeconomic Status								
Household income (ref=$75,000 or more)								
Less than $25,000	0.440***	0.391–0.495	1.672***	1.428–1.958	1.772***	1.423–2.206	1.761**	1.245–2.492
$25,000–49,999	0.653***	0.601–0.709	1.239**	1.096–1.400	1.377***	1.159–1.637	1.149	0.862–1.530
$50,000–74,999	0.837***	0.774–0.906	1.006	0.890–1.138	1.223*	1.022–1.462	1.000	0.725–1.380
Employment status (ref=employed)								
Unemployed	0.893	0.780–1.021	1.832***	1.563–2.148	1.317*	1.049–1.652	1.578*	1.082–2.302
Homemaker	0.998	0.892–1.118	1.689***	1.406–2.028	1.098	0.833–1.447	0.881	0.562–1.380
Student	0.976	0.791–1.205	1.860***	1.364–2.537	0.608	0.294–1.256	3.386*	1.330–8.620
Retired	0.887*	0.788–0.997	2.080***	1.817–2.382	1.259*	1.051–1.508	1.290*	0.972–1.711
Unable to work	0.147***	0.122–0.177	11.391***	9.191–14.132	1.559**	1.213–2.004	1.883*	1.266–2.799
Education (ref=college grad)								
Less than high school	0.488***	0.414–0.575	0.735**	0.595–0.907	1.403**	1.087–1.810	2.287***	1.601–3.267
High school grad/some college	0.785***	0.735–0.838	0.894*	0.811–0.985	1.108	0.972–1.264	1.501**	1.181–1.908
Has health insurance	1.148**	1.036–1.272	1.138**	0.994–1.304	0.946	0.786–1.138	1.094	0.809–1.479
Health History and Behaviors								

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	Self-Rated Health		Functional Limitation		Diabetes		Heart Attack	
Poor mental health	0.466***	0.434–0.501	2.300***	2.095–2.526	1.289	1.132–1.467	1.433**	1.165–1.762
Smoking status (ref=never smoked)								
Former smoker	0.831***	0.775–0.891	1.291***	1.169–1.427	1.071	0.945–1.214	1.525**	1.199–1.940
Current smoker	0.579***	0.531–0.632	1.391***	1.234–1.569	0.930	0.787–1.100	1.458**	1.102–1.931
Weight status (ref=not overweight or obese)								
Overweight	0.650***	0.604–0.701	1.146*	1.028–1.278	2.124***	1.768–2.550	1.406**	1.091–1.812
Obese	0.363***	0.335–0.392	1.696***	1.521–1.892	6.216***	5.235–7.381	1.888***	1.478–2.411
Binge drinker	1.153***	1.061–1.253	0.713***	0.630–0.807	0.641***	0.522–0.786	0.839	0.602–1.169
Exercise	1.803**	1.731–1.878	0.655***	0.592–0.725	0.763***	0.676–0.862	0.805*	0.666–0.975
HIV risk behaviors	1.063	0.874–1.292	1.212	0.924–1.592	1.158	0.784–1.711	1.764*	1.045–2.978
AIC	128235.2		38156.2		22010.07		10170.42	
c[a]	0.745		0.799		0.817		0.834	
McFadden's Pseudo-R^2	0.315		0.251		0.254		0.242	

Note: Adjusted odds ratios and 95% confidence intervals reported from binary logistic regression models;

* p<.05;

** p<.01,

*** p<.001

All models control for gender, age, race/ethnicity, marital status, presence of children in the household, total number of people in the household, metropolitan status, receipt of routine physical health checkup in past 2 years, and state fixed effects

[a]The c-statistic represents model goodness-of-fit. Models are considered reasonable when the c-statistic is greater than .700 (Hosmer and Lemeshow 2000).